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EXAMINER	
LEE, HSIEN MING	

ART UNIT	PAPER NUMBER
2823	

DATE MAILED: 03/19/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/056,154	Applicant(s) FORTIN ET AL.	
	Examiner Hsien-Ming Lee	Art Unit 2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 3-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1 and 3-27* is/are rejected.

7)☒ Claim(s) *28-35* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Remarks

1. Claims 1 and 3-35 are pending in the application.

2. The objection to claim 26, 29, 31, 32, 34 and 35 and 112-second paragraph rejection to claim 32 are withdrawn.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1, 4, 6-8, 11, 12, and 14-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hu (US 6,392,302) in view of Lee (US 2002/0001946)

In re claims 1, 4, 7, 8, 15, Hu teaches the claimed method for forming cobalt silicide on a body which has a surface that comprises silicon 18, the method comprising:

- forming a cobalt layer 26, using physical vapor deposition (PVD), on the silicon surface 18 (Fig.4);
- forming a titanium layer 28 (thickness: approximately 100) over the cobalt layer 26, wherein the titanium layer 28 is deposited on the cobalt layer 26 to be in contact with the cobalt layer 26 (Fig.4);
- reacting the cobalt layer 26 with the silicon surface 18 to form cobalt silicide 30 (Fig.5) and
- removing the titanium layer 28 and un-reacted cobalt layer 26 (Fig.5).

Hu is silent as to the titanium layer 28 being formed by a ionized physical vapor deposition (IPVD) and the body is attached to a support biased with an AC power of 0 W.

Lee, however, in an analogous art, teaches utilizing IPVD for forming the titanium layer would provide a better step-coverage of the titanium layer on the underlying structure, in which the AC bias is in a range of 0 to 500 W (paragraph [0020]).

Therefore, one of the ordinary skill in the art, at the time the invention was made, would have been motivated to deposit the titanium layer of Hu in a manner as suggested by Lee, utilizing the IPVD method having AC bias in the range of 0 W, since by doing so it would improve the step-coverage on the underlying feature, wherein the underlying feature has recess as shown in Fig.4 of Hu.

In re claim 6, Hu also teaches that at least part of a sidewall surface 24 of the opening is made of a dielectric (i.e. TEOS). (col. 4, lines 18-20, Hu)

In re claim 11, Hu in view of Lee also teaches that the forming acts are performed in a chamber at below-atmospheric pressure (i.e. a pressure of 1 to 100 m Torr; paragraph [0020], Lee) without exposing the body to atmospheric pressure between the forming acts because both titanium and cobalt layers are deposited in the PVD processor (col. 4, lines 37-40, Hu).

In re claim 12, the selection of the thickness of the titanium layer is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). For example, the thickness of the titanium layer is determined by the dimension of the device

and the aspect ratio of the opening. In this case, applicant is required to demonstrate the criticality, generally by showing that the claimed thickness range would achieve unexpected results relative to the prior art range. See M.P.E.P. 2144.05 III

In re claim 14, Hu in view of Lee teaches that the ionized physical vapor deposition is performed in a chamber with the body situated on a pedestal coupled to a bias source that provides AC current for helping ionize gas to produce gas ions that dislodge titanium from a titanium target in the chamber (i.e. ionize titanium from the titanium target). (paragraph [0020], Lee)

In re claim 16, Hu in view of Lee also teaches that the body comprises a region consisting largely of silicon 10 a silicon oxide layer 24 extending along the silicon region 10 (Fig. 3); the method includes, prior to the forming acts, removing at least part of the silicon oxide layer to substantially expose at least part of the silicon region 10 (i.e. forming the oxide spacers 24 to expose the silicon region 10); and at least part of the cobalt layer 26 is formed along the silicon region 10 where it is substantially exposed (Fig.4, Hu).

In re claim 18, Hu in view of Lee further teaches that the body comprises a first region comprising silicon 10 and a second region 24 situated on the first region 10, an opening extending through the second region down to the first region 10; the cobalt layer 26 extends at least into the opening down to the first region; and the titanium layer 28 extends at least into the opening above material of the cobalt layer 26 at the bottom of the opening (Fig.4, Hu).

In re claim 19, Hu in view of Lee also teaches that the method includes, prior to the forming acts, removing material of the silicon oxide layer 24 at the bottom of the opening to substantially

expose the silicon substrate region 10 at the bottom of the opening; and at least part of the cobalt layer 26 is formed along the silicon substrate region 10 at the bottom of the opening (Fig.4, Hu).

In re claims 17 and 20, Hu in view of Lee also teaches that the body comprises a region consisting largely of silicon 10 and a silicon oxide 24 layer situated along the silicon region 10; the reacting act includes oxygen in the silicon oxide to dissolve in the titanium layer 26.

5. Claims 3, 5, 13, 21 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hu (US '302) in view of Lee (US '946) as applied to claims 1, 4, 6-8, 11, 12 and 14-20 above and further in view of D'Couto et al. (US 6,342,133).

In re claims 3 and 13, Hu in view of Lee teaches the claimed method, as stated above, but does not teach that the distance between a titanium target and the body is at least 140 mm during the titanium layer deposition.

However, D'Couto et al. in an analogous art of IPVD deposition teach that the distance between the titanium and the substrate (i.e. the body) can be 215 to 240 mm (col.6, lines 18-28), which is determined by the considerations of the layer uniformity and avoiding charging damage (col. 9, lines 4-43).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to select a proper distance between the titanium target and the body as taught by D'Couto et al. in the IPVD method of Hu in view of Lee to be at least 140 mm since by this manner it would form a uniform titanium layer and prevent the body from charging damage. (col. 9, lines 4-43, D'Couto et al.)

In re claims 5, 21 and 22, Hu view of Lee teaches the claimed method, as stated above, but does not expressly teach that the opening has an aspect ratio of at least 2.5 (claims 5 and 22) or at least 1.3 (claim 21).

However, the IPVD technique is a directional deposition method, which is known to the application of deep opening, as evidenced by D'Couto et al. In particular, D'Couto et al. teach utilizing the IPVD for depositing the titanium layer in the deep opening having an aspect ratio of 5 (col.5, line 44 through col.6, line 6).

Therefore, it would have been obvious to one of the ordinary skill in the art at the time the invention was made to apply the method of Hu in view of Lee to the situation of the opening having the aspect ratio of at last 2.5 as taught by D'Couto et al., since the IPVD method is a good candidate for better step coverage in such high aspect ratio. (col. 5, line 61 through col.6, line 6, D'Couto et al.)

6. Claims 9-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hu (US '302) in view of Lee (US '946) as applied to claims 1, 4, 6-8, 11, 12 and 14-20 above and further in view of Liu et al.(US 6,329,277).

Hu in view of Lee teaches the claimed method, as stated above, but fails to teach heating the body and cobalt silicide layer to reduce the resistivity of the cobalt silicide layer, wherein the heating act comprises rapidly thermally annealing (RTA) the body and cobalt silicide layer.

Liu et al., however, in an analogous art forming cobalt silicide teach subjecting the cobalt silicide to the RTA for reducing the resistivity of the cobalt silicide. (col.4, lines 12-15, 56-58).

Therefore, one of the ordinary skill in the art, at the time the invention was made, would have been motivated to utilize the RTA as taught by Liu et al. after forming the cobalt silicide of

Hu in view of Lee, since by doing so it would reduce the resistivity of the cobalt silicide. (col.4, lines 12-15, Liu et al.)

7. Claims 23-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hu (US '302) in view of Lee (US '946) as applied to claims 1, 4, 6-8, 11, 12 and 14-20 above and further in view of applicants' admitted prior art (hereinafter referred as "AAPA") and Horiguchi et al. (US 2001/0002712).

In re claims 23-26, Hu in view of Lee teaches the claimed method, as stated above, but fails to teach that the body comprises an erasable programmable read-only memory region; and the cobalt silicide layer is formed to contact a doped monocrystalline silicon section of erasable programmable read-only memory region.

However, AAPA in Figs 1-2 and related text teaches that the body comprises an erasable programmable read-only memory region (i.e. MOS); and the cobalt silicide layer 210 is formed to contact a doped monocrystalline silicon section 104 of erasable programmable read-only memory region.

Therefore, one of the ordinary skill in the art, at the time the invention was made, would have been motivated to apply the method of Hu in view of Lee to the application of the erasable programmable read-only memory region formed on the doped monocrystalline silicon section as taught by AAPA, since the method of Hu in view of Lee is illustrative instead of restrictive. The aforementioned application is within the level of the ordinary skill and would not depart from the spirit and scope of the teachings of Hu in view of Lee. In particular, Hu teaches that the method can apply to the manufacturing of memory device. (col. 6, lines 22-41, Hu)

In re claim 27, Hu in view of Lee and AAPA teaches the claimed method and further indicates that the teachings can be applied to the manufacturing of DRAM (col. 5, lines 5-6 and col. 6, lines 12-13, Hu), but do not expressly teach that the body comprises a floating gate, a control gate and an electrically insulating material surrounds the floating gate and separates the gate from each other and from the substrate.

However, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to recognize that a conventional DRAM would comprises the floating gate, the control gate and the electrically insulating material surrounds the floating gate and separates the gates from each other and from the substrate, as evidenced by Horiguchi et al.. Horiguchi et al. teach a memory cell which comprises the floating gate 5, the control gate 7 and the electrically insulating material 6 surrounds the floating gate 5 and separates the gates 5 and 7 from each other and from the substrate 1 (Fig.2F).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to utilize the teachings of Hu in view of Lee to form the memory device comprising the floating and control gates and electrically insulating material separated the gates, since similar process can reasonably be expected to yield product which inherently have the same properties. *In re* Spada 15 USPQ2d 1655 (CAFC 1990); *In re* DeBlauwe 222 USPQ 191; *In re* Wiegand 86 USPQ 155 (CCPA 1950).

Allowable Subject Matter

8. Claims 28-35 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

9. The following is a statement of reasons for the indication of allowable subject matter:

The prior art of record neither teaches nor suggest forming a pn junction with each source/drain region, the floating gate extending *partially over* at least one of the source/drain regions (claims 28, 33); forming a further titanium layer over the further cobalt layer by ionized physical vapor deposition and reacting cobalt of the further cobalt layer with silicon of **the other of the source/drain regions** to form further **cobalt silicide** layer (claims 31, 35); and forming a **select gate** overlying the substrate lateral to the floating gate (claim 32).

Response to Arguments

10. Applicant's arguments filed 12/16/03 have been fully considered but they are not persuasive.

In re claims 1, 4, 7, 8, 15, applicant's argument is on the ground that there is no motivation to combine Lee with Hu because titanium layer 28 in Hu is removed after forming silicide layer 28 and has no incentive to use IPVD to improve the electromigration resistance of later-formed aluminum layer 24. (page 13, third paragraph).

In response to the argument, even though the above argument is true, Lee still provides a motivation for using IPVD in Hu's method because using IPVD would improve step-coverage of titanium layer on the underlying feature (paragraph [0020], Lee). With the recess feature as shown in Fig.4 of Hu, using IPVD technique of Lee to form titanium layer 28 of Hu in the recess, the step-coverage can be improved. Thus, the combination of Hu and Lee is deemed proper.

In addition, by using PVD technique to form cobalt layer 26 and subsequently forming titanium layer 28 thereon in the recess (Fig. 4 and col. 4, lines 37-40, Hu), one of the ordinary

skill would have recognized that the acts of forming cobalt 26 and titanium 28 are performed in a same chamber at below atmospheric pressure (paragraph [0020], Lee) without exposing the body to atmospheric pressure between the two forming acts. (last paragraph, page 13).

In re claims 3, 5, 13, 21 and 22, applicant also argued that D'Couto et al. do not provide any motivation or incentive for combining (fourth paragraph, page 14).

Contrary to the argument, D'Couto et al teach that by selecting the distance being 215 to 240 mm (col. 6, lines 18-28) between the titanium target and the substrate (i.e. equivalent to the body), it would improve the titanium layer uniformity and avoid charging damage (col. 9,lines 4-43).

Therefore, one of the ordinary skill in the art would have been motivated to select a desired distance, as suggested by D'Couto et al, during forming titanium layer of Hu in view of Lee to obtain uniform titanium layer and prevent any undesirable damage to the body.

In re claims 9-10, applicant further argued that Liu et al. do not provide any motivation or incentive for combining (first paragraph, page 15).

Contrary to the argument, Liu et al. teach that subjecting the cobalt silicide (i.e. CoSi) to the RTA would convert the CoSi to CoSi2, which, in turn, would reduce the resistivity of the CoSi (col. 4, lines 12-15 and 56-58). Thus, the combination of Hu, Lee and Liu et al. is deemed proper.

In re claims 23-27, applicant also argued that background prior art (i.e. AAPA) and Horiguchi et al. do not provide any incentive or motivation for combining (first paragraph, page 16).

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Particularly, Hu suggests that the method can be applied to the manufacturing of memory device, such as DRAM (col. 5, lines 5-6 and col. 6, lines 22-41). AAPA also teaches the application of memory device (Figs. 1-2 and related text). Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to apply the method of Hu in view of Lee to the application of memory device. Furthermore, Horiguchi's teachings is used to remedy the deficiency of Hu in view of Lee and AAPA, as stated in the previous Office Action. Thus, the above combination is deemed proper.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 571-273-1863.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hsien-Ming Lee
Examiner
Art Unit 2823

March 14, 2004